Dynamic aperture of non-scaling FFAG with sextupole

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http://hadron.kek.jp/~machida/doc/nufact/
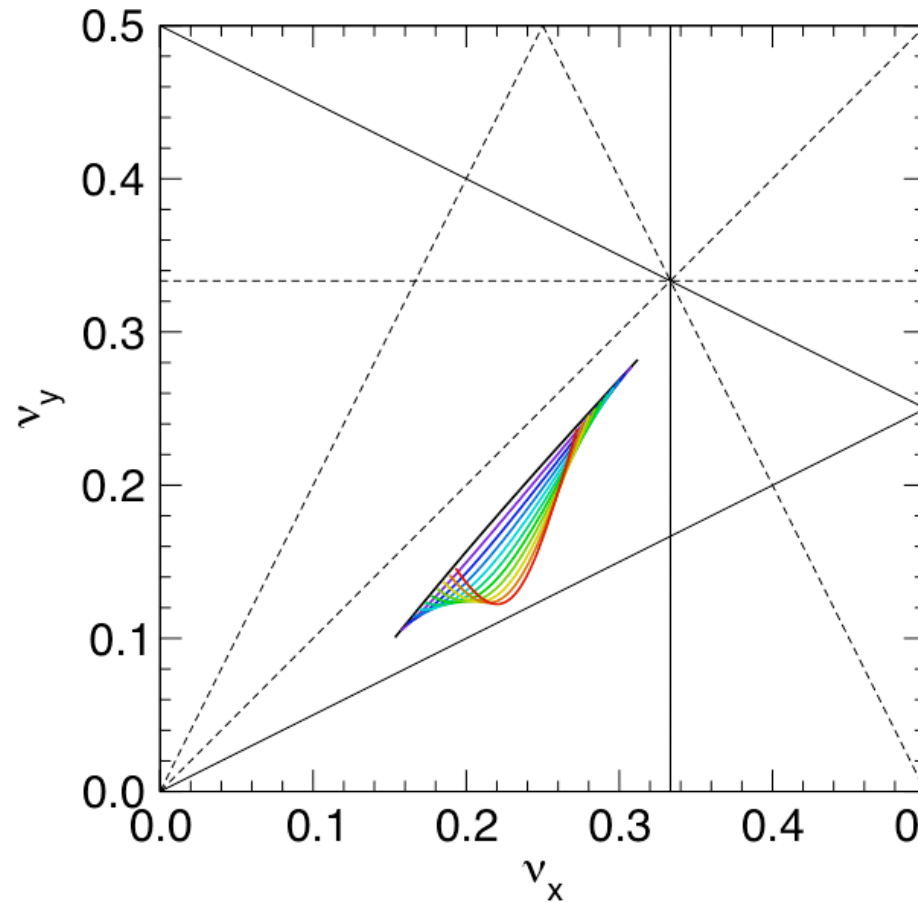ffag/machida_20060721.ppt & pdf

Non-scaling FFAG with sextupole
new optics by Scott Berg

Berg made a new optics which
does not cross 3rd order resonance.

See if this new optics has any
improvements in dynamic aperture.

Different colors show different
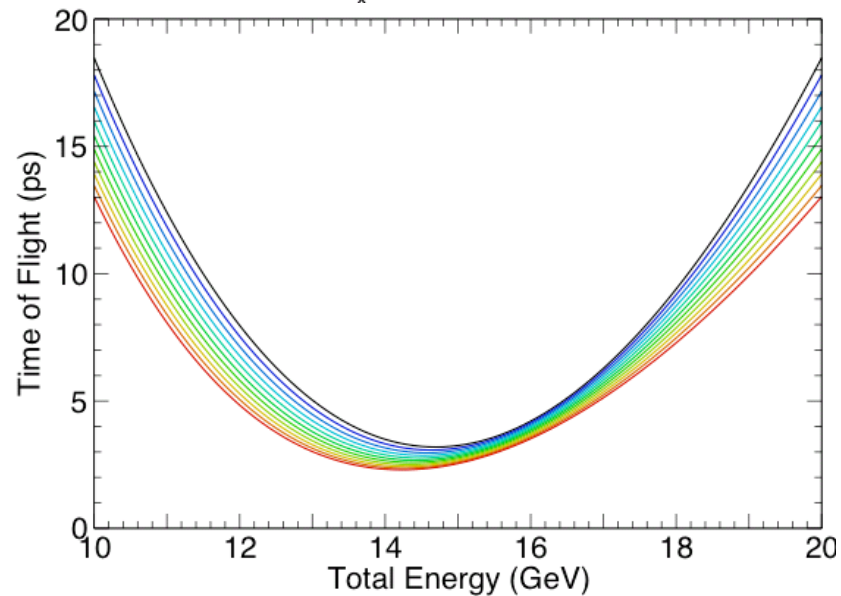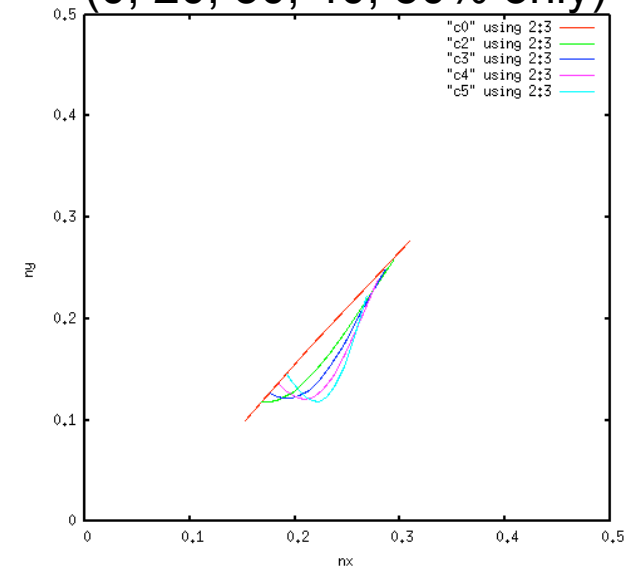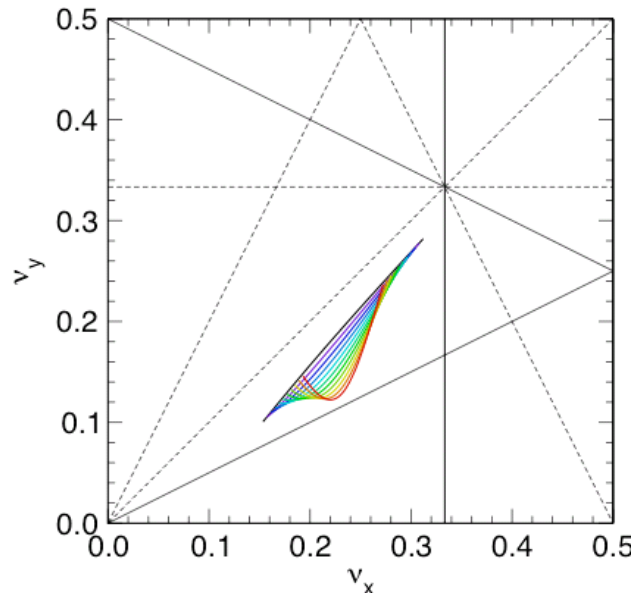setting of chromaticity correction:
0, 5, 10, …, 50%.

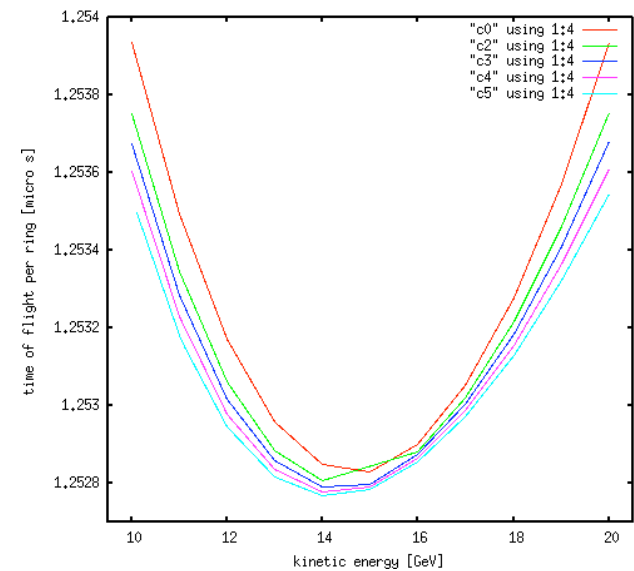# Non-scaling FFAG with sextupole
Berg's optics   vs.   S-code modeling
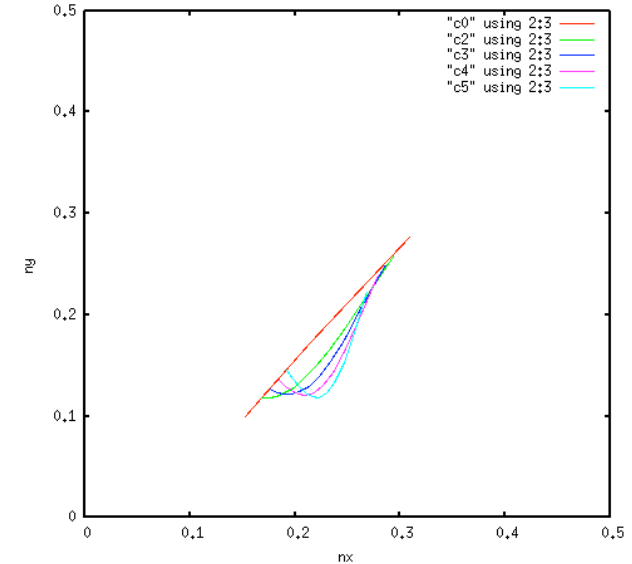
(0, 20, 30, 40, 50% only)

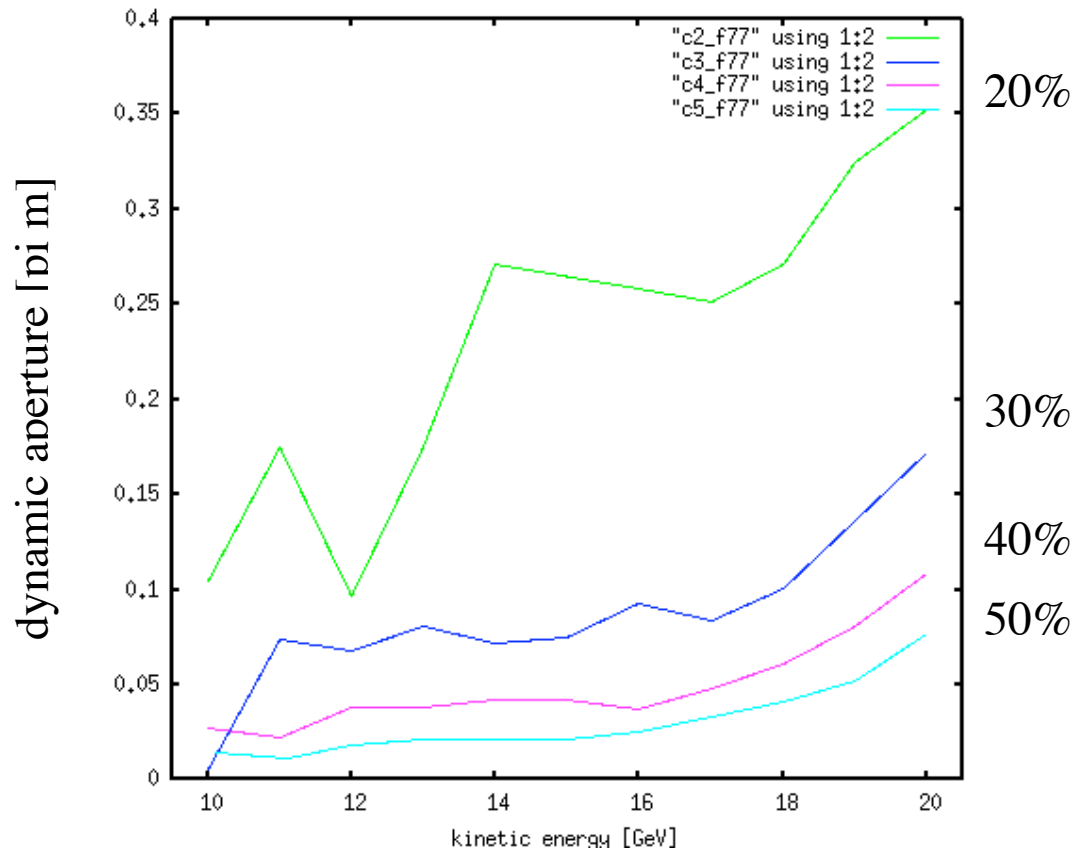Tune diagram

Time of flight

3

Non-scaling FFAG with sextupole
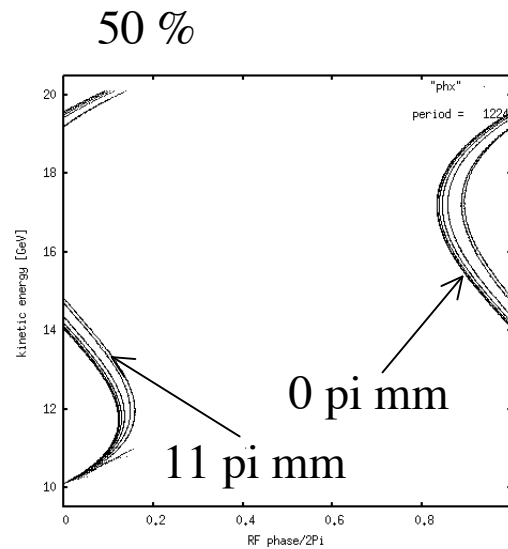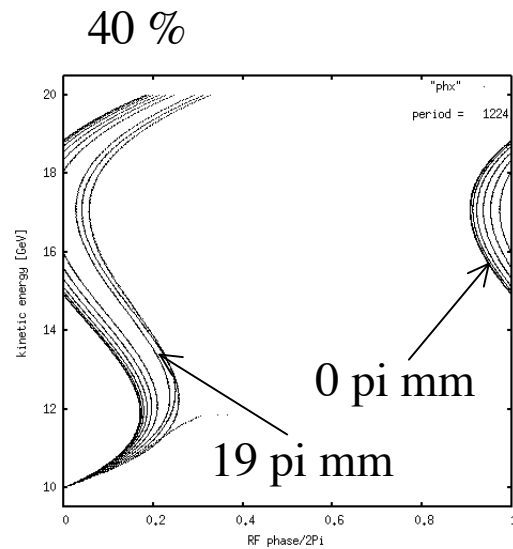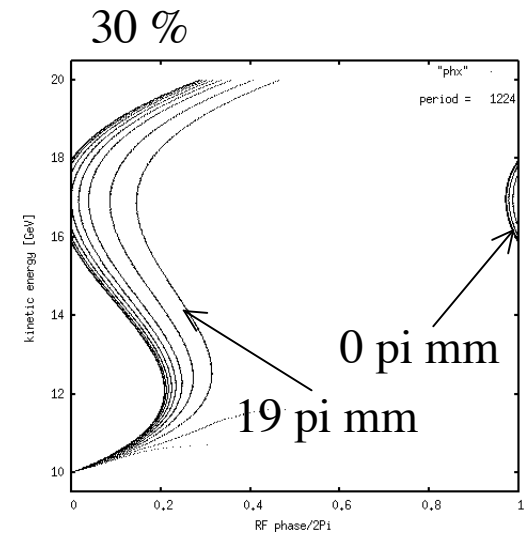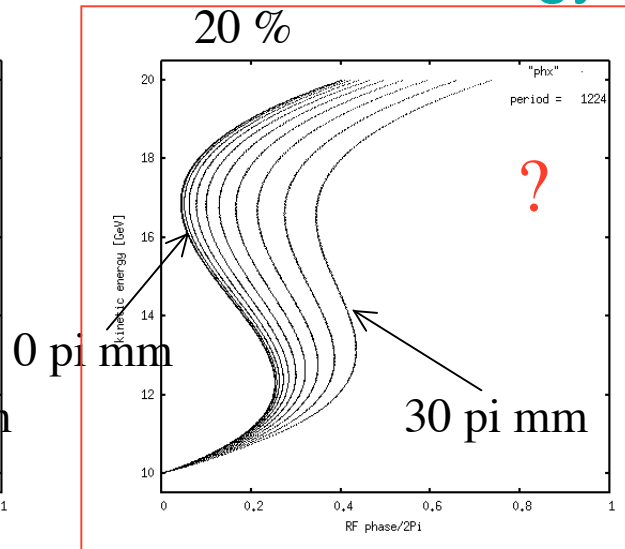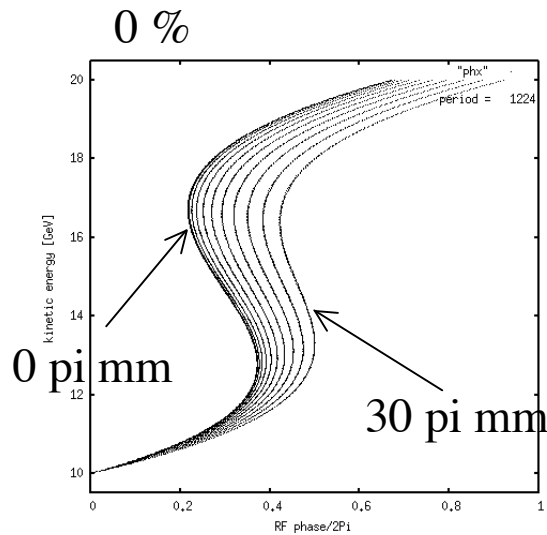## dynamic aperture

With more than 40% of sextupole, dynamic aperture becomes less than 30 pi mm.

Non-scaling FFAG with sextupole

with constant energy gain

0 %

20 %

30 %

?

0 pi mm

0 pi mm

0 pi mm

30 pi mm

30 pi mm

19 pi mm

40 %

50 %

Time of flight variation
can be corrected with
chromaticity correction.
(constant energy gain)

0 pi mm

0 pi mm

19 pi mm

11 pi mm

5

Non-scaling FFAG with sextupole
accelerate out of bucket

0 %

20 %

30 %

?

0 pi mm

0 pi mm

0 pi mm

24 pi mm

30 pi mm

30 pi mm

40 %

50 %

0 pi mm

0 pi mm

11 pi mm

11 pi mm
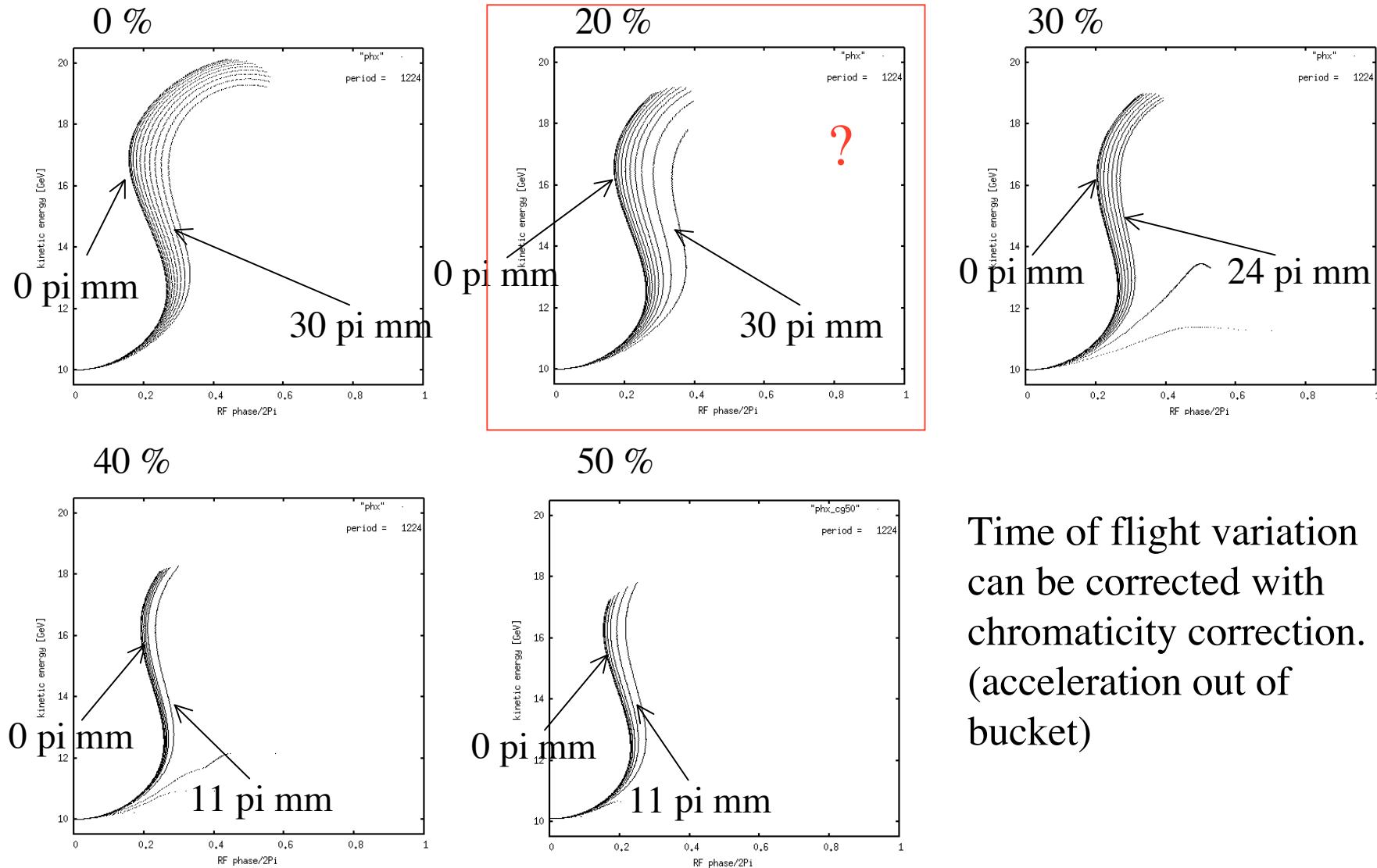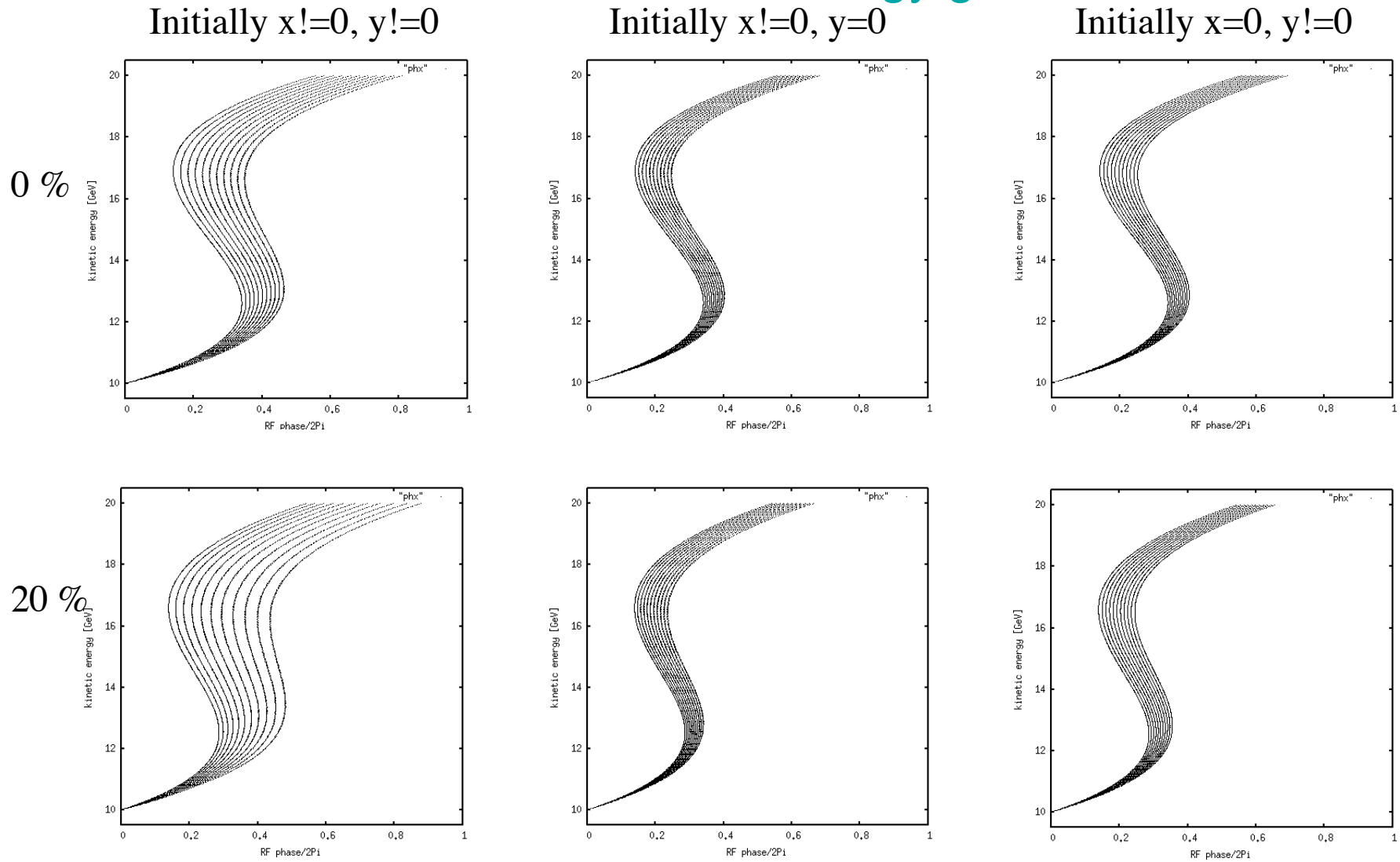
Time of flight variation can be corrected with chromaticity correction. (acceleration out of bucket)

Non-scaling FFAG with sextupole
with constant energy gain

Initially x!=0, y!=0   Initially x!=0, y=0   Initially x=0, y!=0
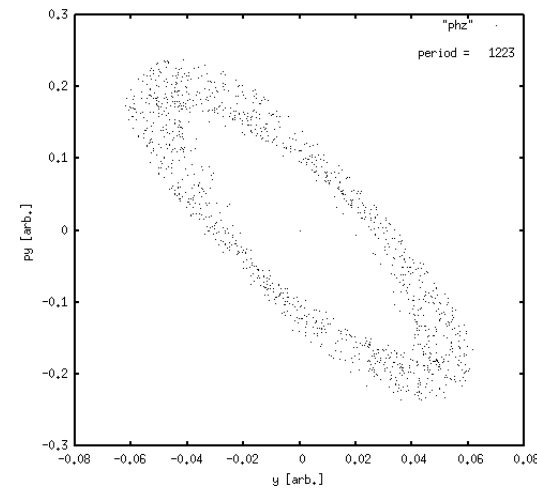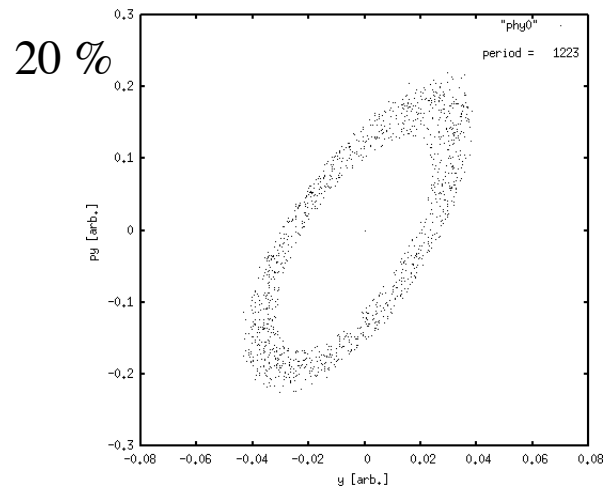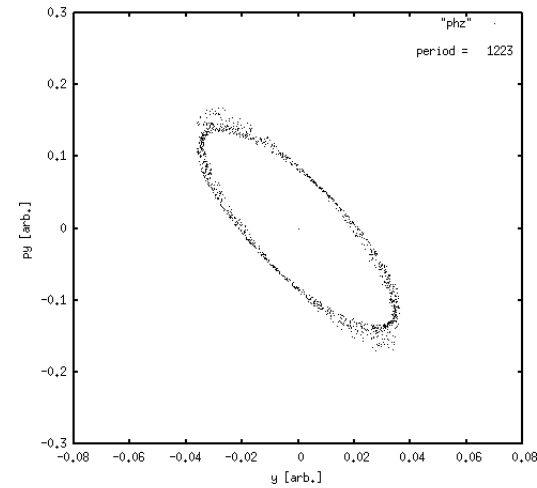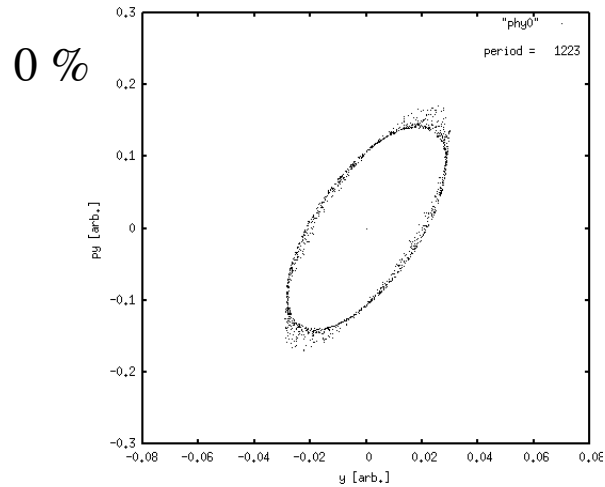
0 %

20 %

Slight reduction of phase slip with 20% sextupole
except when both x and y are not zero initially.

Non-scaling FFAG with sextupole
with constant energy gain

Horizontal phase space of 30 pi mm   Vertical phase space of 30 pi mm

0 %

20 %

Larger phase slip of 20% sextupole is caused by transverse emittance growth.   8

Summary

- Problem of path length variation with finite transverse amplitude can be corrected with sextupole.

- However, with more sextupole strength, dynamic aperture becomes less. Need to find compromise between them.

- Dynamic aperture is suffered also locally with resonances. For example, a dip on dynamic aperture may be due to nx=0.25 and ny=0.25.
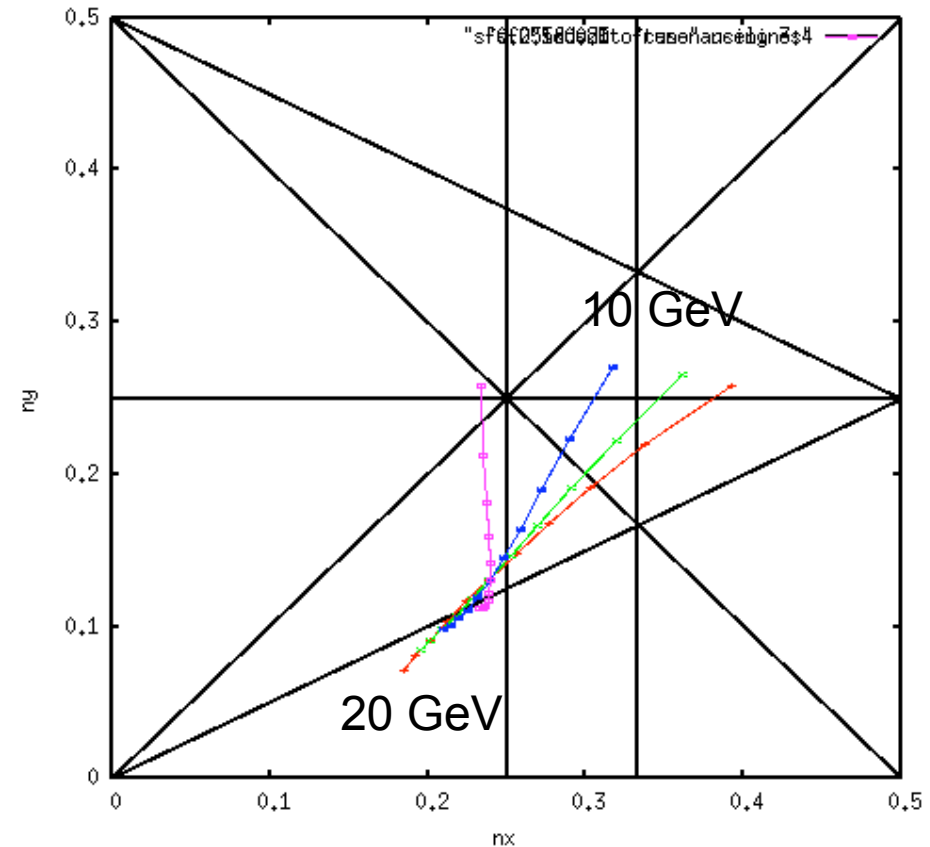
Non-scaling FFAG with sextupole (previous)
tune excursion

Both SF and SD sextupoles are installed at QF and QD*.

Strength are relative to the one required for full chromaticity correction in a SAD (MAD) model.

*Although SF is more effective than SD as pointed out by Koscielniak(tridn-2005-98.pdf), SF only makes vertical tune unstable at high momentum.
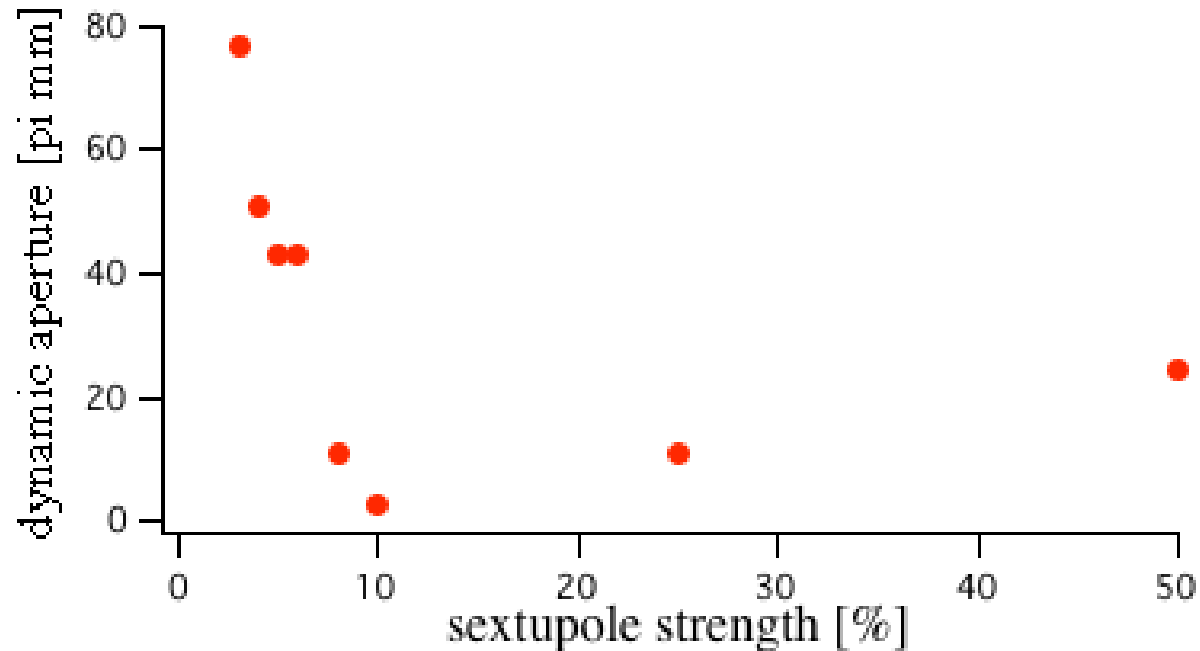

Sextupole strength:
Red   0%
Green   10%
Blue   25%
Magenta 50%

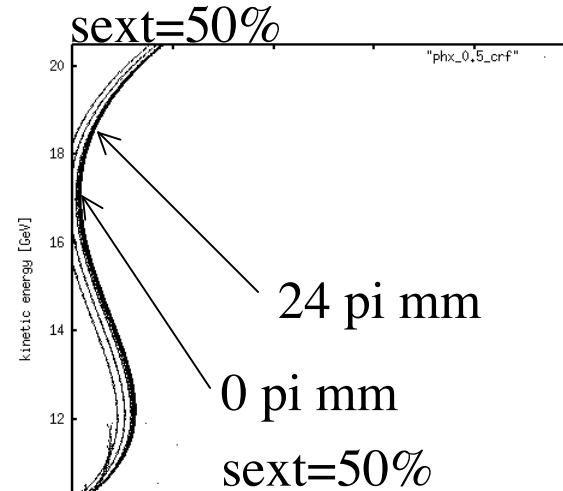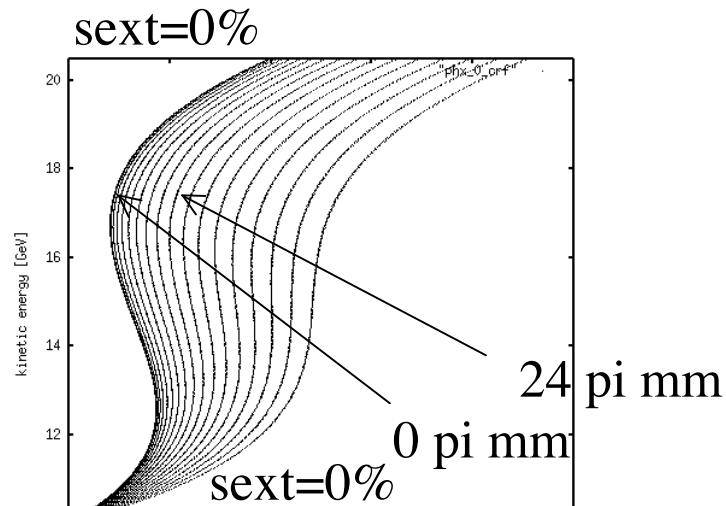# Non-scaling FFAG with sextupole (previous)
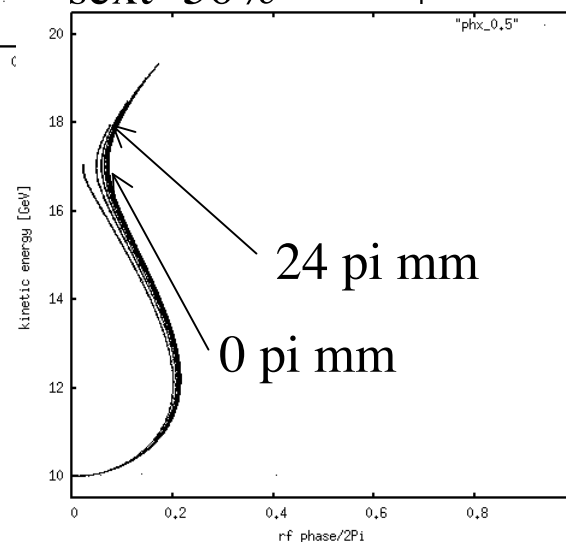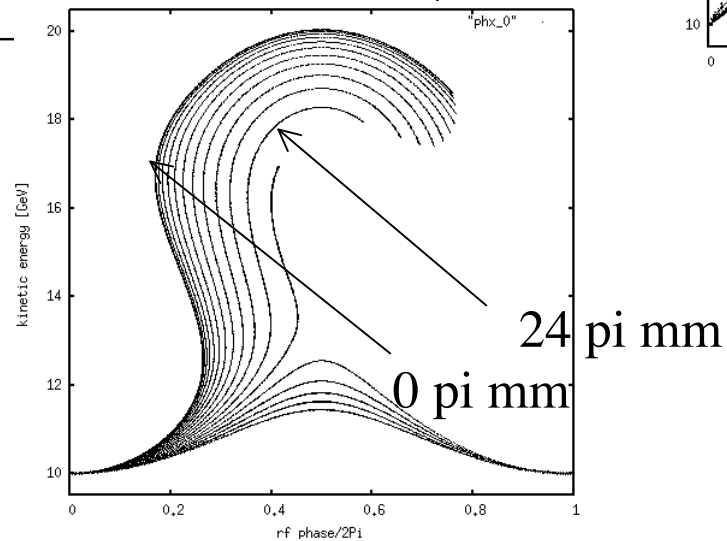## dynamic aperture at injection

- Sudden decrease of dynamic aperture with sextupole.
- Gradual increase with stronger sextupole.

Non-scaling FFAG with sextupole (previous)
time of flight variation

sext=0%

sext=50%

24 pi mm

0 pi mm

24 pi mm

0 pi mm

with constant energy gain

sext=0%

sext=50%

24 pi mm

0 pi mm

24 pi mm

0 pi mm

Accelerate outside of bucket

Path length variation is reduced with (Hor.) chromaticity correction.